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Case Report

Cerebral Herniation Secondary to Stroke-Associated Hemorrhagic Transformation, Fulminant Cerebral Edema in Setting of COVID-19 Associated ARDS and Active Malignancy

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SARS-CoV-2 infection has been associated with ischemic stroke as well as systemic complications such as acute respiratory failure; cytotoxic edema is a well-known sequelae of acute ischemic stroke and can be worsened by the presence of hypercarbia induced by respiratory failure. We present the case of a very rapid neurologic and radiographic decline of a patient with an acute ischemic stroke who developed rapid fulminant cerebral edema leading to herniation in the setting of hypercarbic respiratory failure attributed to SARS-CoV-2 infection. Given the elevated incidence of cerebrovascular complications in patients with COVID-19, it is imperative for clinicians to be aware of the risk of rapidly progressive cerebral edema in patients who develop COVID-19 associated acute respiratory distress syndrome.

Key Words: Coronavirus—Cerebral edema—Ischemic stroke—SARS-CoV-2

Introduction

COVID-19 infection due to the novel Coronavirus is associated with systemic hyperinflammatory state and hypercoaguability 1; recent reports suggest an association between COVID-19 and ischemic stroke.[2] Cytotoxic edema is associated with ischemic stroke and typically peaks within days 3−5; in cases of large hemispheric infarct, malignant cerebral edema can lead to mass effect and herniation. Many metabolic factors can worsen cerebral edema, such as hyponatremia, hypercapnia, and hyperammonemia, amongst others.[3] Hypercapnia is known to induce vasodilation of the intracranial vessels leading to increased cerebral blood volume and in severe cases, cerebral edema. COVID-19 infection has been shown to induce acute respiratory distress syndrome (ARDS) and acute respiratory failure; in patients with ischemic stroke, this may lead to acutely worsening cerebral edema. We report a case of rapidly progressive cerebral edema and herniation in a patient with COVID-19 associated respiratory failure and ischemic stroke.

Case report

A 72 year old woman with breast cancer on chemotherapy and blood loss anemia due to gastrointestinal bleed presented to an outside hospital with sudden onset left sided weakness beginning several hours prior to presentation; NIHSS was 6 for left arm plegia, partial left homonymous hemianopia, and right gaze preference. She had also endorsed dyspnea when supine for the preceding week. She was not given tPA due to thrombocytopenia, and was transferred to our center for consideration of endovascular therapy. On arrival, CT brain showed a posterior division right MCA/parietal stroke and CT angiogram showed no large vessel occlusion, indicating recanalization (Fig. 1A,B). Perfusion CT showed a matched 22 ml core and perfusion deficit.

Nasopharyngeal swab was positive for SARS-CoV-2 on RT-PCR assay. Labs were also notable for platelet count of 15 (160-410 k/mm), LDH 779 U/L (125-220 U/L), mild transaminitis, neutropenia, and hemoglobin of 4.2 mg/dl

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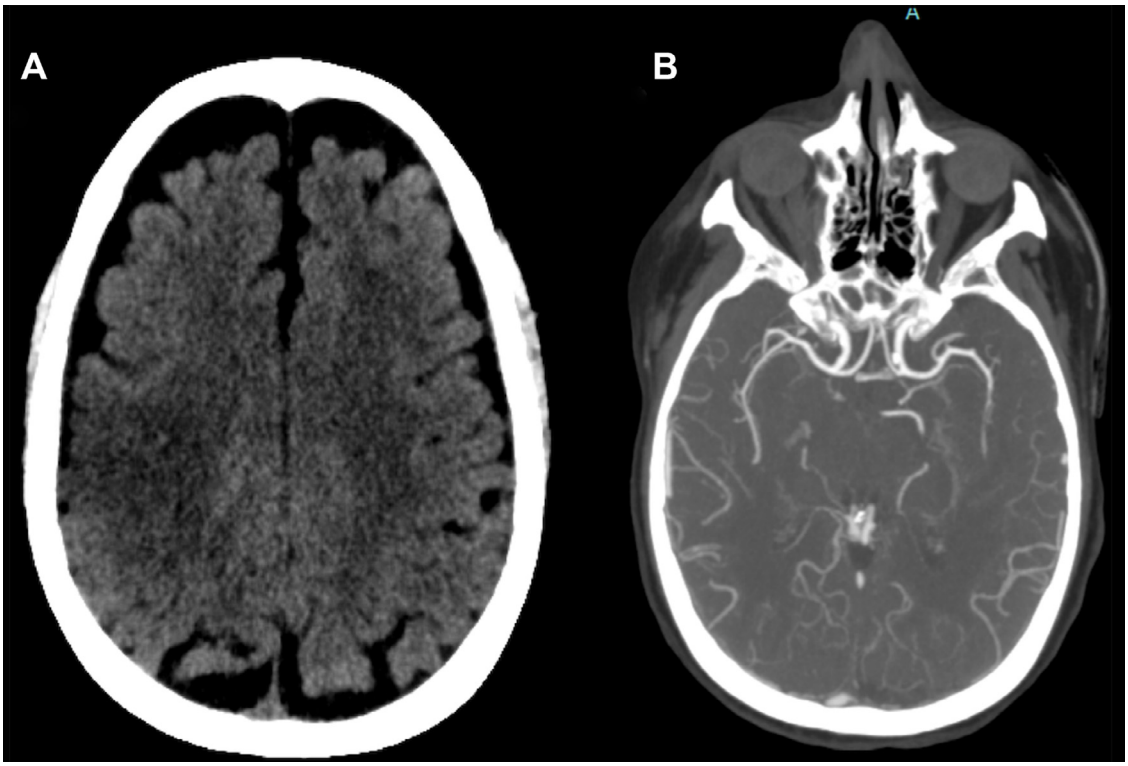

Fig. 1. *1A shows completed right parietal stroke; 1B demonstrates spontaneous recanalization of the parent vessel*

(12.0-15.0 mg/dL) on admission. The patient was admitted to the COVID-19 intensive care unit; antiplatelet therapy was withheld in the setting of thrombocytopenia and she required both 3 units of packed red blood cells as well as one unit of platelet transfusions. On post-stroke day 4, the patient developed acute respiratory failure with hypoxia to 50% on pulse oximetry and hypercarbia on ETCO2 nasal sampling cannula associated with an abrupt rapid decline in her mental status with abrupt loss of cortical responses, and bilateral pupillary reflexes and only a right corneal reflex present. This culminated in emergent intubation, followed by a rapid CT which demonstrated significant worsening mass effect, malignant cerebral edema and hemorrhagic transformation of the infarct (Fig. 2). Given the patient's medical comorbidities, she was transitioned to comfort care.

Discussion

COVID-19 is known to induce a hyperinflammatory state and hypercoaguable state, which may have precipitated the ischemic stroke in this patient, it is also possible that the patient's systemic malignancy contributed to her hypercoaguability. Cytotoxic cerebral edema is a well-described complication of ischemic stroke, particularly malignant middle cerebral artery infarction, but is typically associated with with larger strokes involving more than half the middle cerebral artery territory. The degree and rapidity of deterioration in clinical exam was out of proportion with what is expected with with a stroke of this size and location. In this case, the patient's abrupt decline during hospitalization was likely multifactorial: thrombocytopenia may have been related to both the chemotherapy as well as the underlying COVID-19 infection and likely contributed to the patient's hemorrhagic transformation and exacerbated the development of cerebral edema. Acute respiratory failure in the face of COVID-19 infection likely led to hypercarbia, and this hypercarbia likely potentiated the rapidity and severity of the cerebral edema. Hypercarbic respiratory failure has previously been associated with the development of fulminant cerebral edema,[4] although the rapid progression seen in our patient was atypical. Acute respiratory distress syndrome (ARDS) is a well-documented complication of COVID-19 infection, and can lead to a severe and rapid respiratory decline leading to hypercarbia and hence precipitate cerebral vasodilation via perivascular extracellular pH changes.[4] In our case, the patient had additional precipitating factors of thrombocytopenia due to concomitant chemotherapy as well as concomitant hematologic derangements from COVID-19 infection which may have increased the likelihood of hemorrhagic transformation; it is likely that these issues also played a role in the patient's neurologic decline.

Given the elevated incidence of cerebrovascular complications in patients with COVID-19, it is important for

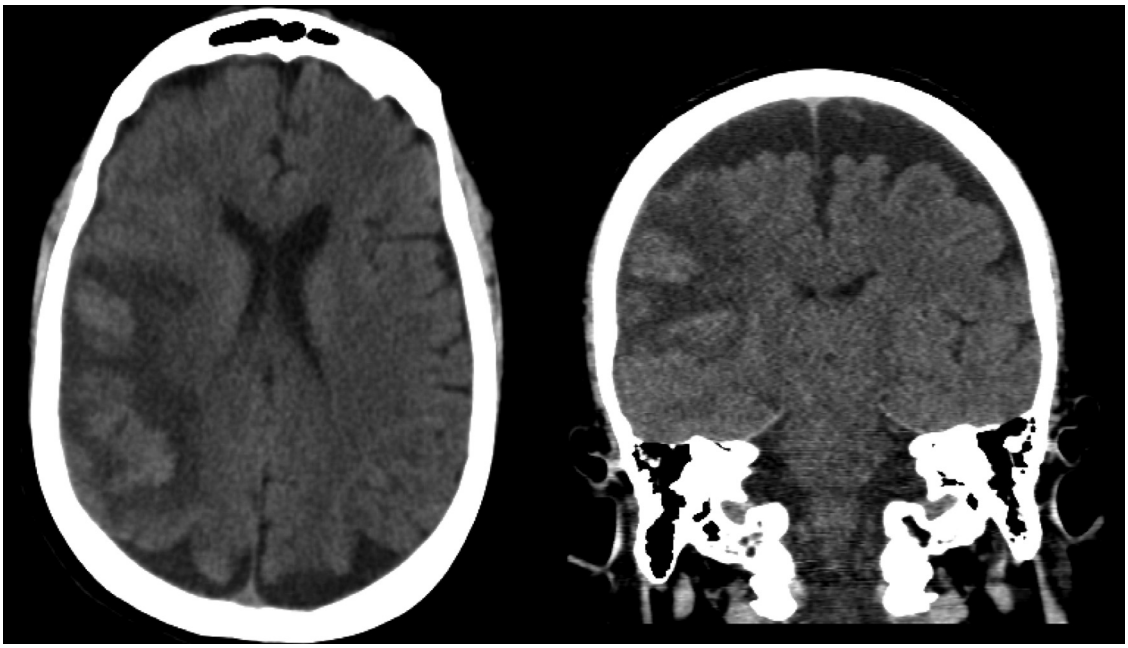

Fig. 2. *Worsening mass effect, hemorrhage and edema after the patient's respiratory decline.*

clinicians to be aware of the potential for this association and to preemptively monitor for hypoxia and hypercarbia and monitor for signs of rapid deterioration especially in patient at higher risks for hypercoaguable states.

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